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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

A SURVEY OF FOREST INSECT INFESTATIONS ON CUTOVER AREAS IN CALIFORNIA

By

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A SURVEY OF FOREST INSECT INFESTATIONS ON CUTOVER AREAS

IN CALIFORNIA

INTRODUCTION

Because of the importance of losses caused by forest insect infestations in virgin stands and the unplumbed possibilities of controlling those losses by variations of present cutting practices, the Bureau of Entomology and Plant Quarantine, with cooperation of the Office of Management, Region 5, U. S. Forest Service, projected and consummated a survey of losses on cutover areas during 1934.

The objects of this project were: (1) To determine the importance of losses caused by forest insects on cutover areas in California, and to determine the relationships existing between (2) loss and increment; (3) loss and site index; (4) loss and timber type; (5) loss and methods of cutting; (6) loss and time after cutting; (7) loss and diameter distribution; (8) loss and tree class distribution, as well as to determine the status of infestations in pole stands and reproduction on cutover areas.

The major features of infestations on cutover areas during 1932 and 1933 were the subject of study in an effort to determine existing conditions. If existing conditions were found to be unsatisfactory, it was hoped remedies would be suggested by the data secured.

COST OF SURVEY

Two field crews of from three to four men were engaged in securing information from the middle of April to the middle of September. The Bureau of Entomology and Plant Quarantine supplied a portion of the funds to pay salaries and expenses, the U. S. Forest Service paying the major portion of salaries and expenses from IMPNIRA Insect Control Funds.

The approximate costs of the work and the division of expense between the Bureau and Forest Service are shown in the following itemized list, consideration being given to deduction for time spent on other projects.

U. S. Bureau of Entomology and Plant Quarantine		
Supervision - Salary	$ 600.00	
Crew Supervisor - Salary	830.00	
Assistant to Technicians - Salaries	400.00	
Expenses and Transportation	380.00	$2210.00
U. S. Forest Service		
Salaries - Junior Foresters	1660.00	
" Assistant to Technicians	1000.00	
Expenses and transportation	260.00	$2920.00
GRAND TOTAL - -		$5130.00

MATERIALS AND METHODS

Twenty three plots, varying in size from 120 to 640 acres each, and eight traverses covering 320 acres supplied information for analysis. Data from one other plot wasrejected as it contained a considerable area of uncut timber.

The information gathered concerning each plot consisted of general information concerning the area, stand and logging operation and more specific information, using standard methods, concerning the amount of reserve timber, number of poles, reproduction conditions and losses in those three classes of growing materials. Increment borings were made from representatives of Dunning's tree classes 1, 2, 3 and 6 on each plot to determine increment and growth trends. Cores also were taken from infested trees in the reserve. A map, showing topography, timber type and cultural developments was made for each plot.

Location of plots, and other descriptive information, is given in the following table:

TABLE I.

Plot No:	Forest	Township	Range	Section	Acres	Ownership	Timber cut By	Year: Cut:	Method of Logging
CO 1	Shasta	45N	2E	34	160	Govern't	Weed (Long-Bell)LmbCo.	1925:	Caterpillars and Wheels
CO 2	"	44N	1E	32	120	"	" " "	1922:	" " "
CO 3	"	44N	1E	29 & 32	160	Private	" " "	1922:	" " "
CO 4	"	43N	3W	28	640	Govern't	Trespass by Weed "	1905:	Horses and wheels
CO 5	Modoc	43N	5E	20	320	Private	Weed (Long-Bell) "	1930:	Caterpillars
CO 6	Lassen	33N	9E	35	320	Govern't	Fruit Grow.Supply Co.	1929:	"
CO 7	"	32N	8E	1	320	"	" " " "	1931:	"
								1932:	
CO 8	"	32N	9E	23	320	"	" " " "	1927:	"
								1928:	
CO 9	"	31N	9E	14	320	"	" " " "	1922:	Big Wheels
								1923:	
CO 10	"	30N	8E	13	320	"	Lassen Lmbr.& Box Co.	1919:	Horses and slip tongue wheels
CO 11	Stanislaus	4N	18E	30 & 31	160	"	Pickering Lumber Co.	1928:	Donkey engine
CO 12 a	"	4N	18E	28	240	"	" " "	1929:	Caterpillars
CO 12	"	"	"	"	"	"	" " "	1930:	"
Co 13	"	5N	15E	27 & 34	160	Private	Manuel Mill	1904:	Bulls
								1906:	
CO 14	"	4N	18E	17,19,20	320	Govern't	Pickering Lumber Co.	1927:	Caterpillars and donkey engines
CO 15	"	1S	19E	14 & 15	160	"	Calif.Peach Grow.Assn.	1920:	Donkey engines
								1924:	
CO 16	"	2S	19E	14	160	Private	Yosemite Lumber Co.	1924:	" "
CO 17	Sierra	4S	20E	34	160	Govern't	Madera Sugar Pine Co.	1928:	Donkey engines, modified high lead
CO 18	"	5S	20E	21	160	Private	Clarke Mill	1907:	Bulls and trucks
CO 20	"	10S	24E	5	240	Govern't	Prescott Mill	1922:	Donkey engine, Horses and trucks
								1923:	
CO 21	"	5S	21E	28	160	"	Madera Sugar Pine Co.	1905:	Low speed ground lead donkey engine
								1906:	
CO 22	"	9S	25E	16	600	"	Fresno Flume and Irrigation Co.	1907:	" " "
								1911:	
CO 23	Plumas	25N	13E	26	320	"	Clover Valley Lmb. Co.	1926:	Caterpillars and Big Wheels
								1927:	
CO 24	"	24N	13E	17	320	"	Feather Riv.Lmbr.Co.	1923:	Caterpillars and Athey arches

RESULTS

IMPORTANCE OF LOSSES ON CUTOVER AREAS

Table 2 shows losses in ponderosa pine on all plots. Table 3 gives similar information concerning the jeffrey pine and sugar pine stands for plots on which those species occurred in appreciable amounts.

Ponderosa pine losses:

Losses in the reserves ranged from no loss to a loss of 130 b.m. per acre annually, on the 23 plots. Average loss was 25.8 b.m. per acre. In percent of ponderosa pine reserve the average loss was 1.44%, with a maximum of 11.83% on CO 4. The maximum loss was 656% of the increment and the average 94%. On seven plots a net loss resulted, and on four the net increment was less than 1% of the stand. On eight plots the net increment was between 1 and 4% of the stand, and on two plots it exceeded 4%. No increment was determined for two of the plots.

Jeffrey pine losses:

Jeffrey pine occurred in appreciable amounts on but five plots in east side forest areas. Average per acre loss in jeffrey pine was 13.6 b.m. or .07% of the jeffrey pine reserve volume. The loss averaged 57% of the increment. One plot showed a net loss, two a net increment of less than 1% and two others showed a net increment of between 1 and 4%.

Sugar pine losses:

Nine plots contained sugar pine in appreciable amounts in the reserve stand. On three of these plots no increment could be determined from available data. Losses average 71% of the gross increment and net increment ranged from -2.65% of the stand to a gain of 2.93% per year. Losses ranged from nothing to 3.72% of the stand of CO 13, on which a small reserve occurred, and on which a disproportionate amount of loss was caused by the death of one large tree, is excepted.

These results show that the possible gains on cutover lands were reduced by more than half, on the average, for the three pine species. However, examination of the record on individual plots shows a considerable variation. Although conditions were unsatisfactory, even critical on some plots, others showed satisfactory net gains.

LOSS AND INCREMENT

In ponderosa pine the gross increment in relation to losses shows interesting results, not entirely in keeping with present ideas. The minimum increment on any plot is 0.73%, the maximum 5.06%. When the plots are

arranged in order of percent of increment, we find a considerable variation in the losses on plots having nearly similar rates of accretion. However, there is a tendency towards lighter losses on plots having the extremes in the increment range. 5 Plots having increment of less than 1.50% of the stand have losses averaging 0.69% of the stand. 9 plots having increment ranging from 1.50 to 2.00% of the stand have losses averaging 2.57%. 4 plots having increment ranging from 2.60% to 2.50% have losses averaging 1.50% of the stand. 3 plots having increment of over 3.00% have losses averaging 0.15% of the stand.

The five plots on which jeffrey pine occurs show increment varying from 1.02% to 3.46%. Although variation in results occurs, it also appears that the plots showing the intermediate rates of growth have the highest losses/ However, the sample cannot be considered sufficient for any but tentative conclusions.

The six plots containing sugar pine have increments ranging from 1.07 to 2.93% of the stands. The heavier losses appear to be in these plots having the smallest increment rate. These sugar pine plot results show the accepted idea of the relation of infestation to growth rate.

LOSS AND SITE INDEX

Previous studies by Person (1) have shown a definite relation between

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(1) Person, H.L., Report on Studies of Insect Losses on Cutover Areas of District 5. ms. February 20, 1926

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infestation and site quality as expressed by the site index figure.

Examination of the information secured for the three pine species on the cutover plots examined shows some variation from that conclusion, when averages in the various site qualities represented by plots included in this study are examined. These averages are as follows:

Site quality: Index Figure:	Ponderosa Pine:		Jeffrey Pine		Sugar Pine	
	No. Plots:	Ave.% Loss:	No. Plots:	Ave.% Loss:	No. Plots:	Ave.% Loss
5	2	7.82	0		0	
4	9	1.31	3	1.15	0	
3	4	0.21	2	0.18	1	0.00
2	8	0.47	0		8	1.32

In ponderosa pine the 8 plots in site 2 stands showed a greater loss than did those plots in site 3 stands. In sugar pine the better quality stands suffered the greater losses, although it must be considered that the sample in site 3 stands is insufficient to give much weight to the results.

When the variation in loss in each site group is considered, it is evident to me that but a small portion of the complete picture is given by the average. Definite conclusions cannot be reached without more information gathered over a longer period of time.

LOSS AND TIMBER TYPE

It is to be expected that loss would vary with timber type in that the timber type classification, in general, is a classification of environmental conditions. The results secured by the survey are as follows:

Timber type:	Ponderosa Pine:		Jeffrey Pine		Sugar Pine	
	No. Plots:	Ave. % Loss:	No. Plots:	Ave. % Loss	No. Plots:	Ave. % Loss
PP	15	1.62	3	0.16	3	2.01
SP-PP	4	0.69			4	1.12
SP-F	2	0.00			2	0.11
JP	2	3.02	2	1.66		

The above figures appear to show a relationship between timber type and amount of loss in terms of percent of total stand of the susceptible tree species. However, there is great variation in the plot figures that are averaged in the above table. Further analysis of the data secured by the survey has indicated the reasons for this great variation, but more complete data extending over a longer period is necessary before definite conclusions can be reached.

LOSS AND METHODS OF CUTTING

It has been observed that the selection of trees for removal on an entomological basis does not differ greatly from selection on a silvicultural basis. Under such conditions the removal of a small portion of the stand would leave a greater amount of volume in trees considered poor risks, and the removal of a larger proportion of a stand would leave fewer susceptible trees. In addition, there is a possibility that the volume of material available for infestation may be related to the amount of subsequent losses. The record in ponderosa pine is available for study, the sample as regards jeffrey and sugar pine being considered, in general, too small to furnish a satisfactory basis.

Reserve volume per acre:

When the plots are arranged in order of volume of reserve on the ground in 1934, there appears to be no relationship between gross increment in % of stand and volume. Also no relationship exists between % of stand infested and volume. This is true even though only those plots in ponderosa pine type are considered.

Percent of total stand in Reserve.

When the plots are arranged according to the percent of stand remaining in reserve following cutting, the following is to be observed as regards infestation:

% of Stand in Reserve	Timber type	No. plots	Average % of stand infested per year in Ponderosa pine
40-48	SP-PP	2	1.37
21-35	PP	6	0.76
17-18	JP	2	3.02
10-13	PP	4	4.03
Practically clear cut	PP	3	0.26
	SP-F	1	0.00

Examination of the averages fails to show any definite relationship between amount of loss and percent of stand remaining on the area. There is great variation on the individual plots included in the above classes.

The two plots in the SP-PP type, cut lightly under the 1905-1909 selection cutting system, are CO 21 and CO 22 on the Sierra National Forest. Even under the favorable environmental conditions applying to those areas, it is evident losses are heavy and, when considered in connection with losses in virgin timber in nearby areas, are comparable in intensity.

On the plots in which 20 to 25% of the stand remains, four of the five plots, all on the Lassen National Forest in site 3 and site 4 timber, suffered losses of less than 0.20%. The fifth plot in site 5 stands on the Shasta National Forest suffered a loss of 3.82%. Apparently location is an important factor.

Ponderosa pine on the two plots on the Plumas National Forest in site 4 jeffrey pine type, and with less than 20% of the reserve remaining, suffered heavy losses.

Four plots, CO 20 on the Sierra, CO 5 on the Modoc and CO 2 on the Shasta in site 4 quality, and CO 4 on the Shasta in site 5 quality timber, suffered losses of over 1% of the reserve in all cases. All these plots were cut to the extent of from 87 to 90% of the stand.

Cutting, to a point approaching clear cutting, apparently resulted in a negligible infestation. The best comparison of this is shown by CO 2 and CO 3 on the Shasta, which are located within 10 chains of each other. CO 2, cut to the extent of 89% of the stand, suffered an annual loss of 1.54% of the stand during the two year period covered by the record. CO 3, cut to the extent of 97 or 98% of the timber over 12" d.b.h. suffered a loss of but 0.09% of the stand.

The data do not supply a record of variations in cutting under similar conditions to an extent sufficient to supply conclusive evidence. However, it appears that a light cutting does not reduce infestations markedly, whereas a clear cut area in which only the younger and thriftier trees remain suffers practically no loss. It also is evident from qualitative observations, and in spite of the results in averages as given in the table, that loss subsequent to logging depends more on other environmental factors than the amount of timber removed from an area or the amount left and available for infestation.

LOSS AND TIME AFTER LOGGING

It is commonly held that, following logging, a slight flareup in insect activity is followed by a reduction of insect activity on cutover areas to a relatively unimportant level. Person (loc. cit) found that losses on areas that had been cut for some time were not greater than on areas cut but a few years before his examinations were made.

It is considered the many variables of the record secured by the 1934 survey prohibits a quantitative comparison. However, the records on CO 21, CO 22 and CO 4, which were covered by the Bureau of Entomology in previous surveys, bear out Person's contention. It would appear that infestations on cutover areas growing under certain conditions are not only important and resulting in a net depletion of the reserves, but also that infestations bear little relation to time of logging as regards intensity of infestation. It is apparent that infestations on cutover lands bear approximately the same relationship to environmental conditions as they are related in time, as do the variations of infestations in virgin stands.

LOSS AND DIAMETER DISTRIBUTION

Very definite theories have been evolved concerning selection of trees of certain diameters under virgin stand conditions. Plot results show considerable variation in this factor but, when averaged, show little evidence that the curves of diameter selection, as drawn by Person (2) for virgin stand apply on cutover areas. Figure 1 shows the results from the

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2. Person, H. L. Tree Selection by the Western Pine Beetle, Journ. of Forestry 26; 564-578, 1928.

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cutover plots. Although some slight selection of certain diameter classes is evident, the selection appears to be nearly that of a chance selection by the beetles. Diameters above 34" have not been considered because of the small numbers of trees found in the larger diameter classes.

LOSS AND TREE CLASS DISTRIBUTION

Theories concerning the selection of certain types of trees have resulted from studies in virgin stands in which it was discovered that overmature, codominant mature and suppressed trees were selected for infestation in larger proportions than their occurrence in the stand would warrant if selection were by chance. These so-called susceptible types of trees are, in general, included in Dunning's tree classification as class, 4,5,6 and 7.

Examination of selection of tree classes on cutover areas shows a fairly close relationship between the proportions of the total number of infested and green trees in the several tree classes. There are deviations from a chance selection, but selection in cutover areas seems to be quite different from that in virgin stands. In Class 1, there apparently is a considerable lack of selection, while in Classes 6 and 7, there is evident a preference for suppressed trees. Figure 2 shows the relations of distribution of the tree classes in the cutover stands and distribution of insect-caused losses in those classes.

INFESTATIONS IN POLES

Examination of pole stands showed, with the exception of CO 5 on the Modoc forest, that few losses could be traced directly to slash disposal methods practiced during logging. Previous studies by the Bureau of Entomology and Plant Quarantine have shown that there is little danger of outbreaks of engraver beetles in pole stands left on logging operations, unless the operation is discontinued, the tops not lopped or an excessive proportion of the slash shaded. On CO 5 no tops were lopped and slash was not burned. As a result of the shading caused by leaving the limbs on the tops, engraver beetles were enabled to breed up heavy populations and attack large groups of poles.

Pole infestations on other areas appeared to be normal in comparison with those in uncut stands. Several groups of sugar pine were infested with engraver beetles and mountain pine beetle on CO 12 and groups of white fir poles were infested with Scolytus ventralis. However, these losses occurred elsewhwre on areas that had not been logged.

On CO 14 groups of incense cedar were infested by barkbeetles of the genus Phloeosinus and, in the more extreme habitats on that plot, ponderosa pine poles were infested to a slight extent by flathead borers. These losses can be considered normal, particularly when the situations under which they occurred are considered, and cannot be attributed to logging.

INFESTATIONS IN REPRODUCTION.

Several species of minor importance were discovered feeding on reproduction. Two species, causing injury in limited amounts or on limited areas, may prove to be of importance on cutover areas.

A pine sawfly (Neodiprion sp.), a web-spinning sawfly (Itycorsia sp.) and a needle-feeding moth (Zelleria haimbachi Busck) were found in limited numbers, causing a minor type of injury to ponderosa pine and jeffrey pine reproduction through defoliation. A pitch moth (Dioryctria sp. probably ponderosae Dyar) was abundant on poles and reproduction on the two Plumas plots. The attacks of this species on the twigs resulted in the death of those twigs but, under the conditions, the injury cannot be considered of great importance.

On the Plumas plots the work of an unidentified needleminer in white fir was found.

The work of an unidentified shoot moth, which apparently attacks and kills the terminals and to a lesser extent the laterals of a current season's growth, was found on the Lassen National Forest in Jeffrey pine reproduction and poles. Apparently new growth on trees of from 10 20 25 feet in height is preferred. The work of this species was also seen on the Plumas, and to a lesser extent on the other east side forests. Thrifty shoots were attacked and, if a terminal is infested, the result is the formation of a crooked bole.

A tip moth (Rhyacionia pasadenana (Kearf.)) was found active in pure pine type in both the east and west side forest areas.

On CC 5, injury by the tip moth was found to be abundant and the cause of considerable malformation on reproduction of less than six feet in height and growing as dominant trees in unshaded areas. Random traverses to determine the incidence of injury to this type of reproduction showed, on material or less than four feet in height, that 48.7% of the terminals had been infested this season. Injury to the terminal is a primary type, forcing the production of new terminals from lateral shoots. As many as nine codominant terminals, eight of which were infested by the 1934 generation of insects, had been formed on one plant less than 2 feet high through previous attacks by the tip moth.

Count of all buds, to determine the percent infested, was made on 110 trees. All these were dominant trees and a grouping according to height showed a relationship between height and infestation as follows:

Height	No. Trees counted	No. infested buds	No. uninfested buds	% of buds infested
0-2'	66	232	277	45.5
2-4'	22	25	155	14.0
4-6'	22	19	330	5.4

Although occasional infestation of buds on trees over six feet in height or on codominant trees in groups could be found, the injury was of little importance. In practically all such infestations lateral branch tips were the only ones infested.

Examinations on other areas showed infestations were heavier on cutover lands in the ponderosa pine type stands in which that species of tree occurred in relatively pure stands. Infestation was heavier in exposed sunny areas. Evidences of attack were found on the Modoc, Lassen, Stanislaus and Sierra National Forests. Reports of injury have been received from Foresthill district of the Tahoe National Forest and the Sugar Hill plantation in the Warner Mountain division of the Modoc.

RECOMMENDATIONS

The data suggest the importance of environmental factors other than those of stand, as well as the fact that slight modification of stand composition through light cutting practices does not benefit conditions appreciably. It would appear that present day recommendations for light cutting, with rigid selection of susceptible trees for removal, would be of no avail for two reasons. The first of these is that removal of a sufficient number of susceptible trees to change conditions would, in most problem areas, entail the removal of the greater portion of the stand. This is what is accomplished by present day selection and logging practice. The second reason is that the environmental features represented by the stand do not appear to be those that are critical in determining amount of loss or intensityyof infestation. Accordingly it is considered inadvisable to advocate light cutting as a remedy for heavy losses, except on an experimental basis.

Those factors that appear to be critical in controlling infestation intensity are the physical factors of the environment. These cannot be changed, although variations in them in time may make change unnecessary. It would seem that investigation of the effects of those factors on the insects, as well as on the physiology of the the tree species, would yield the greatest results.

The complex of the environment of cutover areas is undoubtedly greatly changed from that of a virgin stand growing under the same conditions. Accordingly, it does not seem logical to assume that results of investigations of infestations under virgin stand conditions apply to cutover areas.

Until such a time as the complex problems of infestations on cutover areas can be solved, it would appear that, on areas of heavy losses, salvage of infested timber is the best way of utilizing values. That such utilization would result in benefits from the entomological standpoint is not known. However, it is certain that, if methods could be worked out to bring the costs to a reasonable level, the method seems to be the only one, under present day environmental conditions, that stands a chance of paying a profit on the timber now going to waste.

TABLE II

PONDEROSA PINE INFESTATIONS

Plot No.	Site Index	Timber Type	%total stand left	Pond. P. Reserve B.M. per A.	Gross Increment per year BM per A.	Gross Increment per year % Stand	Net Increment per year BM per A	Net Increment per year % Stand	Insect Loss Per Year B.M. per acre	Insect Loss Per Year % Stand	Insect Loss Per Year % Increment
CO 1	5	PP	30	3,410	65	1.91	-65	-1.91	130	3.82	200
CO 2	4	PP	11	1,232	21	1.70	2	0.16	19	1.54	90.
CO 3	4	PP	2	305	15	4.98	15	4.89	T	0.09	2.
CO 4	5	PP	10	887	16	1.84	-89	-9.99	105	11.83	656.
CO 5	4	PP	12	1,055	23	2.18	12	1.14	11	1.04	48.
CO 6	4	PP	25	2,736	45	1.63	39	1.42	6	0.20	13.
CO 7	3	PP	33	4,100	128	3.12	121	2.96	7	0.16	5.
CO 8	4	PP	21	1,391	15	1.09	14	1.05	1	0.04	7.
CO 9	3	PP	34	1,135	18	1.57	16	1.42	2	0.15	11.
CO 10	3	PP	35	4,326	44	1.01	36	0.82	8	0.19	18.
CO 11	2	SP-PP	?	6,787	113	1.66	113	1.66	0	0.0	0.
CO 12	2	"	?	2,213	44	1.97	44	1.97	0	0.0	0.
CO 13	2	PP	?	8,810	206	2.33	162	1.84	44	0.49	21.
CO 14	2	PP	?	5,296	69	1.30	42	0.80	27	0.51	39.
CO 15	3	PP	?	2,484	45	1.81	13	0.54	58	2.35	129.
CO 16	2	SP-F	?	71	?	?	-	-	-	-	?
CO 17	2	"	12	53	?	?	-	-	-	-	?
CO 18	4	PP	?	1,795	91	5.06	87	4.85	4	0.21	4.
CO 20	4	PP	13	1,976	40	2.00	6	0.30	34	1.70	85.
CO 21	2	SP-PP	40	2,712	30	1.12	-16	-0.58	46	1.70	153.
CO 22	2	"	48	5,261	38	0.73	-17	-0.31	55	1.04	145.
CO 23	4	JP	18	711	11	1.61	-12	-1.65	23	3.26	209.
CO 24	4	JP	17	486	10	2.11	- 3	-0.68	14	2.79	140.

TABLE III

JEFFREY PINE INFESTATION

Plot No.	Site Index	Timber Type	% Total Stand Left	Pond. pine Reserve BM per A.	Gross Increment Per Year B.M. per A.	Gross Increment Per Year % Stand	Net Increment Per Year B.M. per A.	Net Increment Per Year % Stand	Insect Loss per Year B.M. per Acre	Insect Loss per Year % Stand	Insect Loss per Year % Increment
CO 8	4	PP	21	1,674	17	1.02	15	0.88	2	0.14	12
CO 9	3	PP	34	2,722	51	1.88	48	1.77	3	0.11	6
CO 10	3	PP	35	1,839	64	3.46	59	3.22	5	0.24	8
CO 23	4	JP	18	1,929	21	1.11	-15	-0.79	37	1.90	176
CO 24	4	JP	17	1,454	26	1.77	5	0.34	21	1.42	81

SUGAR PINE INFESTATION

CO 11	2	SP-PP	?	5,002	147	2.93	147	2.93	0	0.00	0
CO 12	2	SP-PP	?	3,268	72	2.18	62	1.89	10	0.29	14
CO 13	2	PP	?	267	?	?	?	?	15	5.73	0
CO 14	2	PP	?	1,188	30	2.55	27	2.24	4	0.31	13
CO 15	3	PP	?	1,396	?	?	?	?	0	0.00	0
CO 16	2	SP-F	?	200	?	?	?	?	0	0.00	0
CO 17	2	SP-F	12	6,337	162	2.55	148	2.33	14	0.22	9
CO 21	2	SP-PP	40	5,469	61	1.12	36	0.66	25	0.46	41
CCO 22	2	SP-PP	48	6,494	69	1.07	-173	-2.65	242	3.72	350

FIG. 1

DISTRIBUTION OF GREEN AND INFESTED TREES IN PONDEROSA PINE RESERVE STANDS ON CUTOVER PLOTS

BY DIAMETERS

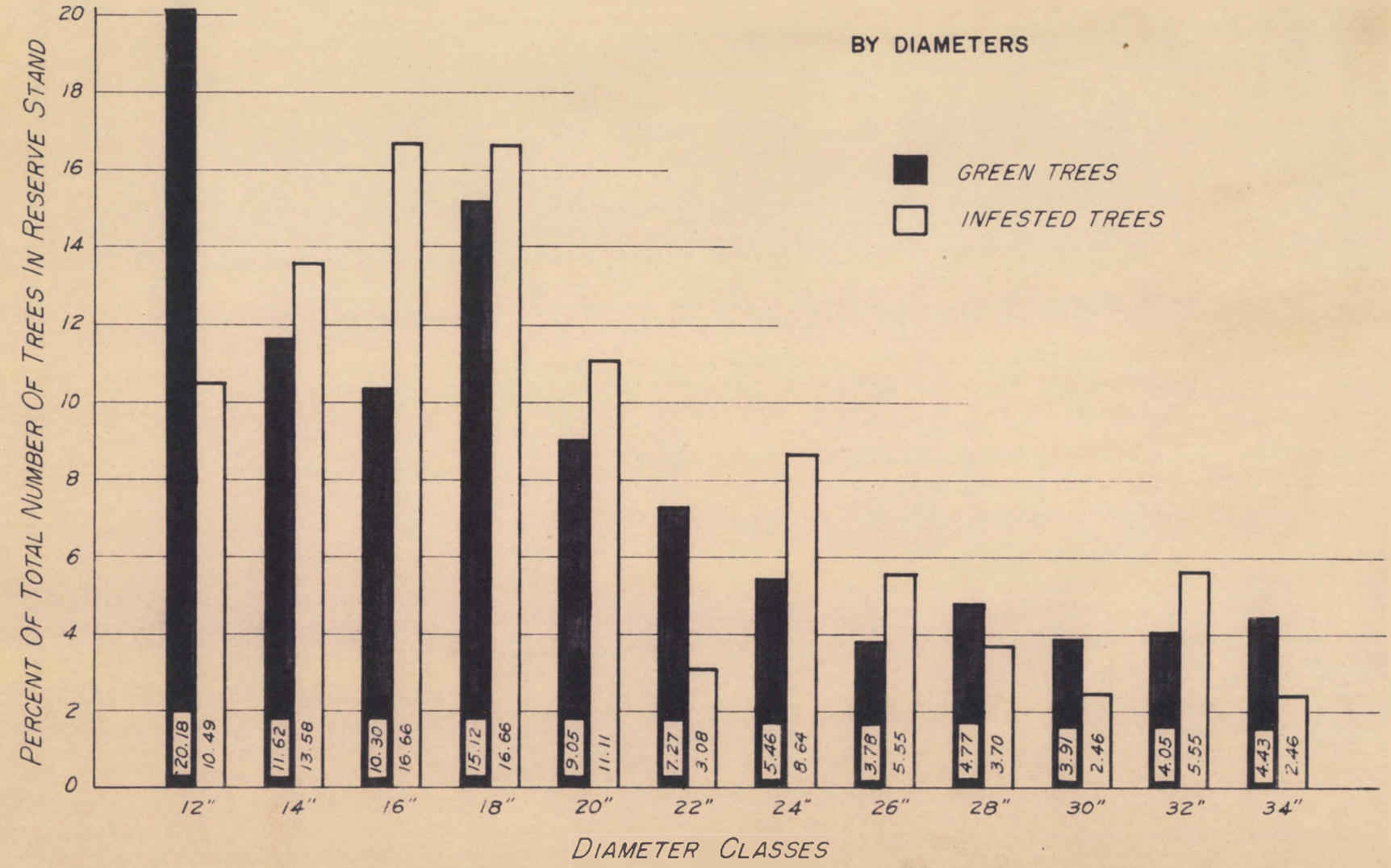
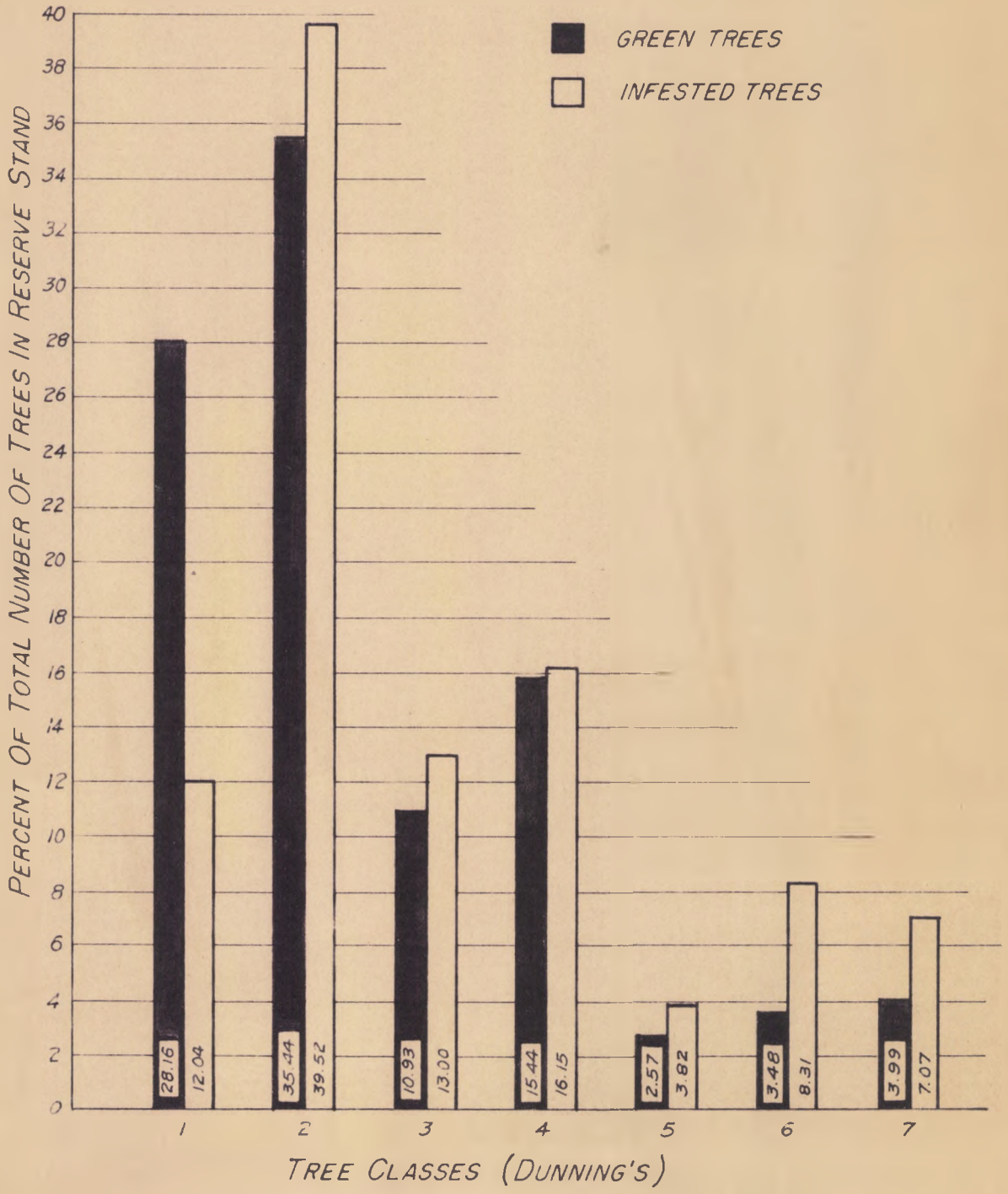


FIG. 2

DISTRIBUTION OF GREEN AND INFESTED TREES IN PONDEROSA PINE RESERVE STANDS ON CUTOVER PLOTS

BY TREE CLASSES



#7590 A- Reserve stand on CO 5 in east side PP type stand, Modoc National Forest. Note the relatively light reserve of younger and more thrifty trees; the snags of trees killed by insects before logging took place; the broadcast slash and unlopped tops. Reproduction in the right center of the picture is heavily infested by tip moth (Rhyacionia pasadenana (Kearf.)). K.A.Salman, June 7, 1934

#7589 B- Results of tip moth attack on reproduction. CO 5, Modoc National Forest. This tree, about 18 inches high and 24 years old, formed nine codominant terminals as a result of previous tipmoth attack. Eight of these terminals, as well as three of the five lateral buds at the tips of branches were attacked by tip moth in 1934.
K. A. Salman, June 7, 1934.

#8576 - Attacks of an undetermined species of Lepidoptera on terminal growth of jeffrey pine reproduction in east side type forests. Note the larva in place within the pith that has been mined out and the effects of attack on the growth of needles of the current year. The thickness of the infested shoots is evidence of the great vigor of the terminals before attack.
J.M.Miller, July 2, 1934.

#8686- Infestation in fir and sugar pine poles and reserve on CC 12, Stanislaus National Forest. This illustrates group kill by Scolytus ventralis Lec. and Dendroctonus monticolae Hopk. in west side SP-PP or SP-F type.

J. E. Patterson, June, 1934.

#8547 - Sugar pine Sale Area near Ellis Meadow, Sierra National Forest. This illustrates loss of seed trees soon after logging. This type of infestation contributes greatly to the production of net loss on cutover areas.- J.M.Miller, October 22, 1931.

#8575 - Loss of sugar pine seed trees some time after logging on CO 12, Stanislaus National Forest. This type of loss appears to be the result of reaction to environmental conditions somewhat similar to that of nearby virgin timber stands. This loss is an important factor in reducing the timber producing capacity of cutover areas.
J.M.Miller- June 21, 1934.